FIELD GUIDEBOOK

to

ENVIRONMENTS OF COAL FORMATION

IN

SOUTHERN FLORIDA

Trip Leaders

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PRE-CONVENTION FIELDTRIP

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SITES TO BE VISITED ON SECOND DAY

During the first part of today's trip, two distinctly different sedimentary environments, those of Florida and Whitewater Bays, will be examined. Florida Bay (Figure 24) is a shallow embayment of the broad continental shelf off western Florida. Virtually the only sediment forming in the bay is calcareous mud composed of metastable carbonate minerals. In contrast, Whitewater Bay is a nearly enclosed lagoonal embayment lying a few miles north of Florida Bay. Whitewater Bay is part of the widespread coastal mangrove swamps of southwestern Florida (Davis, 1940). Sediments in the bay vary from peat to fine-grained calcitic mud. Both Florida and Whitewater Bays formed 3000 - 3500 years ago when the postglacial rise in sea level (Holocene transgression) reached southern Florida (Scholl, in press, A and B). Today's field study will demonstrate rapid facies changes.

STOP 10: Florida Bay Site

Objectives:

A. Inspection of sediment found in an environment occurring adjacent to, and related with, the swamp environments.

B. Discussion of the mineralogical, chemical and physical characteristics of the Florida Bay sediments.

C. Procurement of cores of Florida Bay sediments.

Discussion:

Unconsolidated sediments in Florida Bay are calcareous muds. If lithified, these sediments would be classified as shelly or fossiliferous calcilutites or as biomicrites. Some of the important physical, chemical and mineralogical characteristics of the calcareous sediments of Florida Bay are listed in Table 1.

Seaward of Flamingo, Florida, the sediment in the bay is as much as six feet thick (Figure 25). The sediment overlies the Miami oolite, a limestone of Late Pleistocene (probably Sangamon) age. The sediment does not form a blanket deposit over bedrock but is concentrated in sinuous banks. Most of the mangrove-crested islands in the bay rise from these banks (Figure 24). Radiocarbon dates on a thin layer of peat

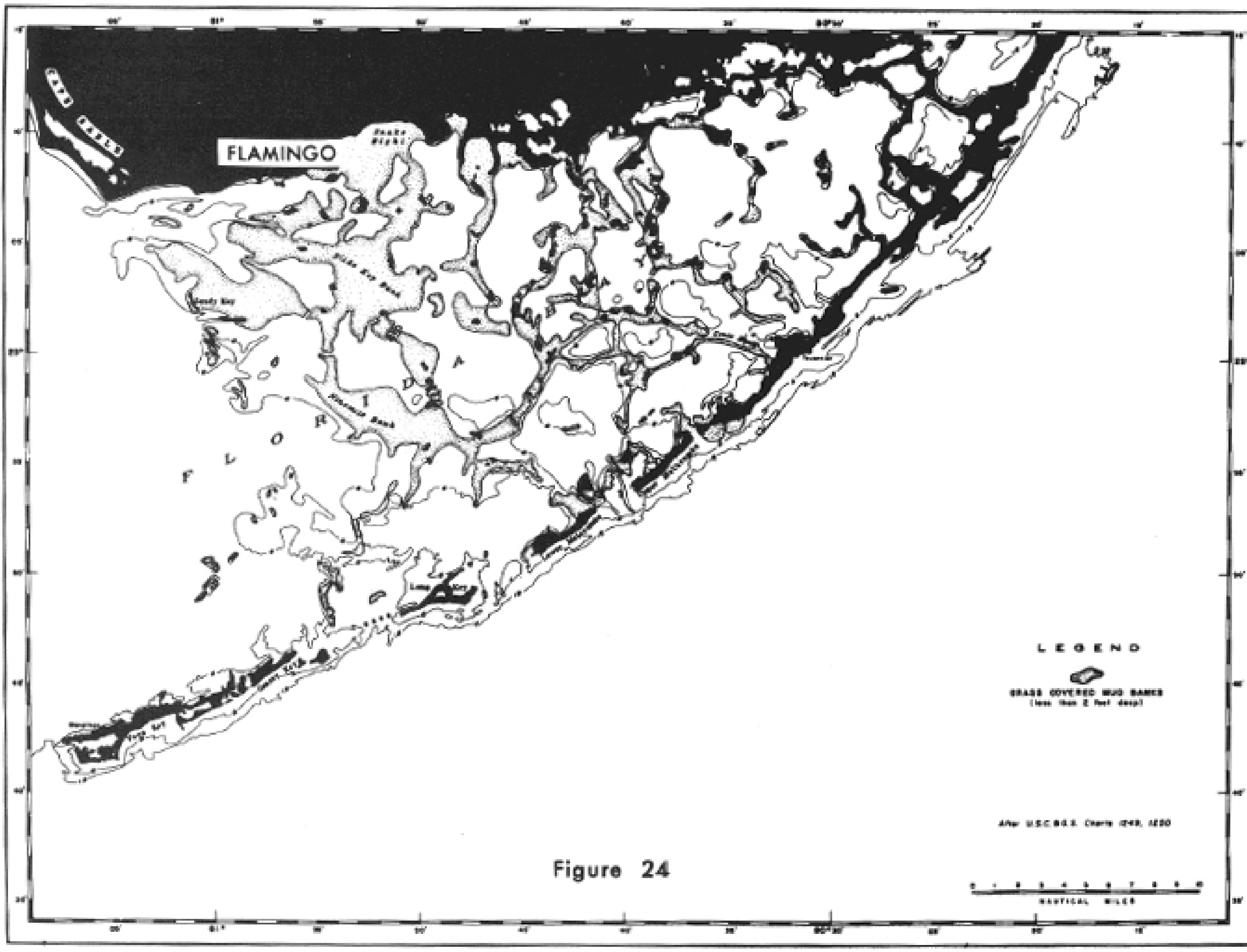


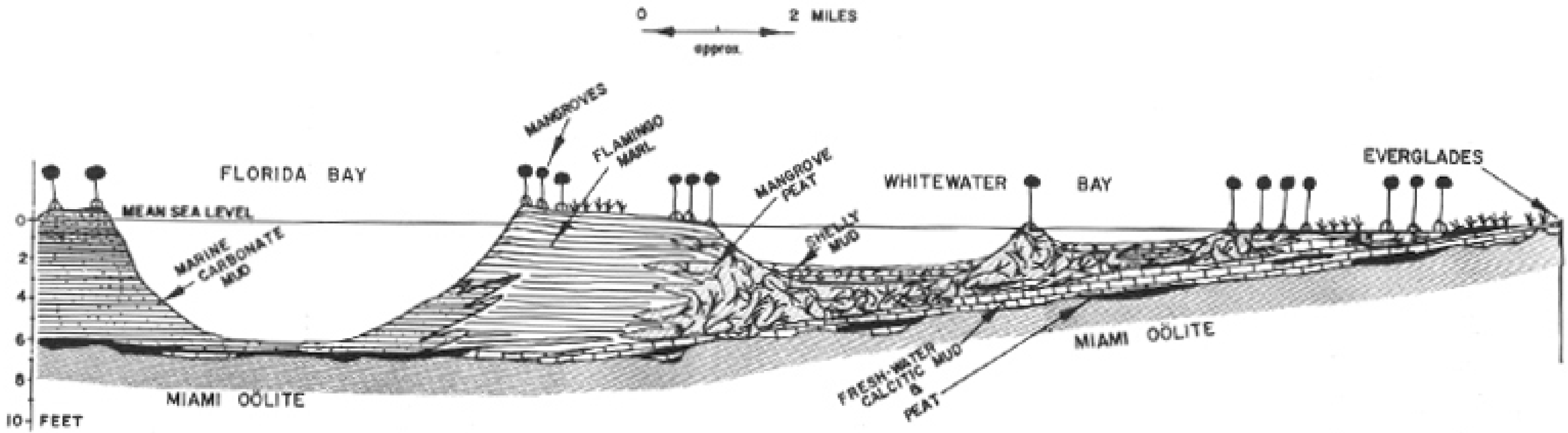
Figure 24. Index map to Florida Bay (from Ginsburg, 1956). Most of the calcareous sediments in the bay are concentrated in the sinuous to irregular-shaped banks. These sediments average about 6 feet thick and overlie the Miami oolite. Near Flamingo, coral in the Miami oolite has a radiocarbon age greater than 30,000 B.P.

Table 1

Properties of Calcareous Sediments in Western Florida Bay[1]

Characteristics	Average Values	Range
Mass properties		
Water content (dry weight)	71.5%	
Porosity	65.9%	
Grain density	2.71 g/cc	
Bulk density	1.58 g/cc	
Grain Size distribution		
Median diameter	0.028 mm	
Trask sorting coefficient	6.81	
Percent >0.062 mm (sand)	30	1-52
Percent 0.062-0.001 mm	48	9-70
Percent < 0.001 mm (subclay)	22	5-50
Carbonate mineralogy		
Percent aragonite	59	35-77
Percent high-Mg calcite	27	3-54
Percent low-Mg calcite	14	1-29
Percent dolomite	present	?
General Chemistry		
Ca/Mg	25	6-41
Sr/Ca X 10^3	8.7	6.3-11.7
Percent calcareous minerals	87	81-90
Percent non-calcareous mineral	9	8-13
Percent organic matter	4	2-6
Percent organic carbon	2.1	1.3-3.7
Percent organic nitrogen	0.15	0.29-0.09
Organic carbon/organic nitrogen	17	13-26

[1]Data are from Taft and Harbaugh (1964) and Scholl (in press, C).



SECTIONAL PROFILE THROUGH FLORIDA BAY AND WHITEWATER BAY

Figure 25

- A schematic generalization of the overall stratigraphic relations of the modern sediments of western Florida Bay, Whitewater Bay, and the Everglades. The line of cross-section runs approximately northward through Flamingo, Florida.

underlying the calcareous sediment and overlying bedrock indicate that the sedimentary fill in Florida Bay began to form about 3500 years ago. A core of this sediment will be taken at Stop 10.

The constituent particles of the calcareous sediment are largely contributed by mollusks and foraminifera. The relatively coarse skeletal parts of these animals are broken down by other animals and plants (e.g. algae) to form the finer fractions of the bay sediment (Ginsburg, 1956; Taft and Harbaugh, 1964).

Mineralogically, sediments in the bay are chiefly composed of the metastable carbonates aragonite and high-magnesian calcite (Figure 26). Low-magnesian calcite and dolomite form only a minor fraction of the sediment (Stehli and Hower, 1961; Taft, 1961; Taft and Harbaugh, 1964). Surprisingly, solution or recrystallization of the metastable carbonate minerals in Florida Bay do not appear to be taking place (Pilkey, 1964; Taft and Harbaugh, 1964).

In the vicinity of Flamingo, Florida and for many miles along the northern shore of Florida Bay, a ridge of bay sediment has been heaped upon the mainland by storm waves (Craighead and Gilbert, 1962). This storm levee of bay mud rises 18-24 inches above sea level and has been termed the Flamingo marl by Davis (1943). The storm levee will be examined at Stop 11.

Landward of this coastal ridge are extensive tracts of brackish-water (Whitewater Bay) and fresh-water swamps (Everglades). The probable relation of the sediments underlying Florida Bay to those in Whitewater Bay and the Everglades is schematically diagrammed on Figure 25.

<u>STOP 12</u>: <u>Whitewater Bay "High Salinity" Site</u>.

<u>STOP 13</u>: <u>Whitewater Bay "Low Salinity" Site</u>.

<u>Objectives</u>:

A. Inspection of the open water sedimentary facies in Whitewater Bay.

B. Discussion of the relationships between the mineralogical plus textural characteristics of the basal calcitic mud and comparable characteristics of the fresh-water marl of the open Everglades.

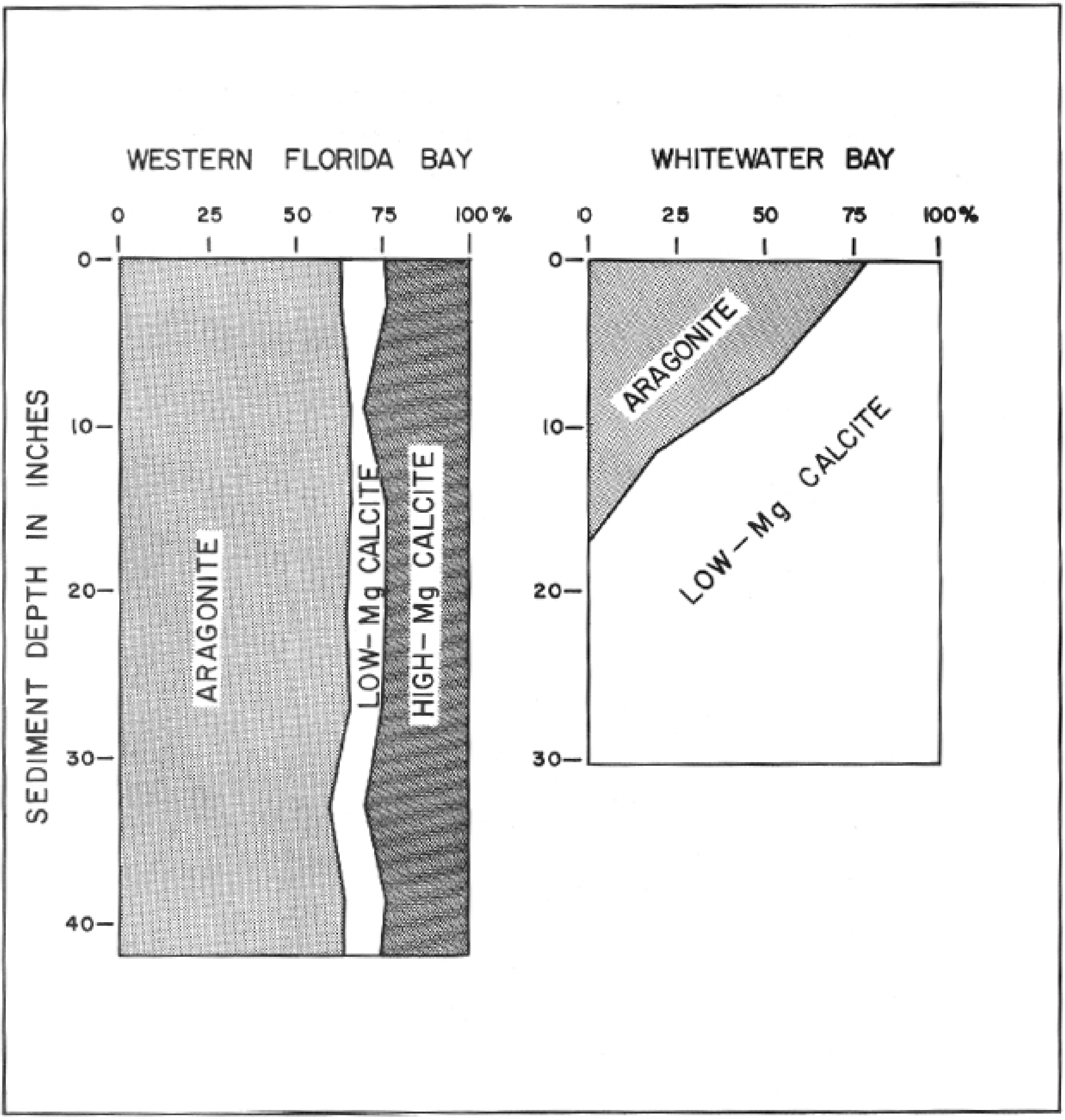


Figure 26 - Relative concentrations of carbonate minerals in sediment cores from western Florida Bay and Whitewater Bay. The lack of aragonite and high-magnesian calcite in the basal portion of the Whitewater Bay core is not due to recrystallization or conversion of these minerals to low-magnesian calcite, but reflects the presence of highly calcitic fresh-water sediments underlying marine and brackish-water deposits.

C. Discussion of the evidences of marine transgression.

Discussion:

Whitewater Bay lies landward of Cape Sable, a broad marshy platform that rises 1 to 2 feet above sea level (Figures 24 and 27). The Cape is in part composed of marsh sediments and the Flamingo marl. A bedrock high may underlie Cape Sable, which possibly initiated the accumulation of the storm and marsh deposits that form the subaerial part of the Cape.

During the dry season, fall to spring months, marine water from the Gulf of Mexico entering the bay through sinuous between-island passes, raises the water salinity in the bay to values similar to those found in Florida Bay (i.e., $35^{o}/oo$). However, high rainfall and mainland runoff during the summer rainy months cause the bay to become very brackish (Scholl, 1963).

In general, a northeast gradient of decreasing salinity can be found in the bay at any time of the year. This is because runoff enters the bay along its northeastern margin.

Unconsolidated sediments in the open water environments of Whitewater Bay are rarely more than four feet thick; they rest on the Miami oolite, the same bedrock platform that underlies Florida Bay to the south. Structural contours on this formation delineate a drainage pattern (Figure 27). Apparently prior to the formation of the bay, streams draining the Everglades crossed this area. Two stops will be made in the bay to collect cores of the sediment fill. One core (to be taken at Stop 12) will be taken along the "high-salinity" (annual range is $26-35^{o}/oo$) or southwestern side of the bay; the other core (to be taken at Stop 13) will be taken along the "low-salinity" (annual range is $4-32^{o}/oo$) or northeastern margin of the bay. Stratigraphic diagrams of typical cores collected along these two sides of the bay are shown on Figures 28 and 29.

Cores taken in Whitewater Bay typically have a basal fresh-water section, a middle brackish-water section, and an upper brackish-water to marine (polyhaline) section. The basal section comprises fresh-water peat and calcitic mud overlying bedrock; these fresh-water units were

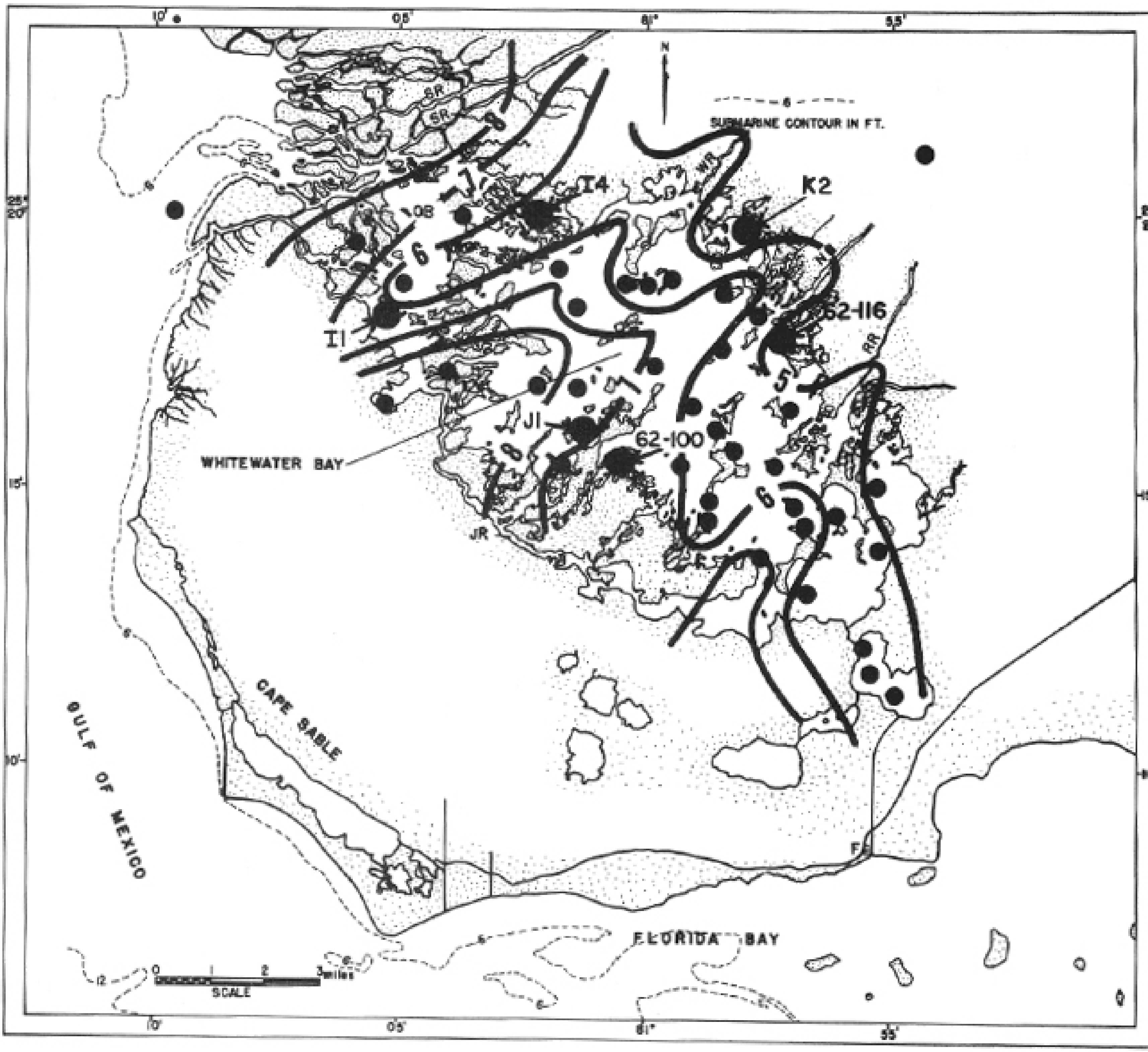
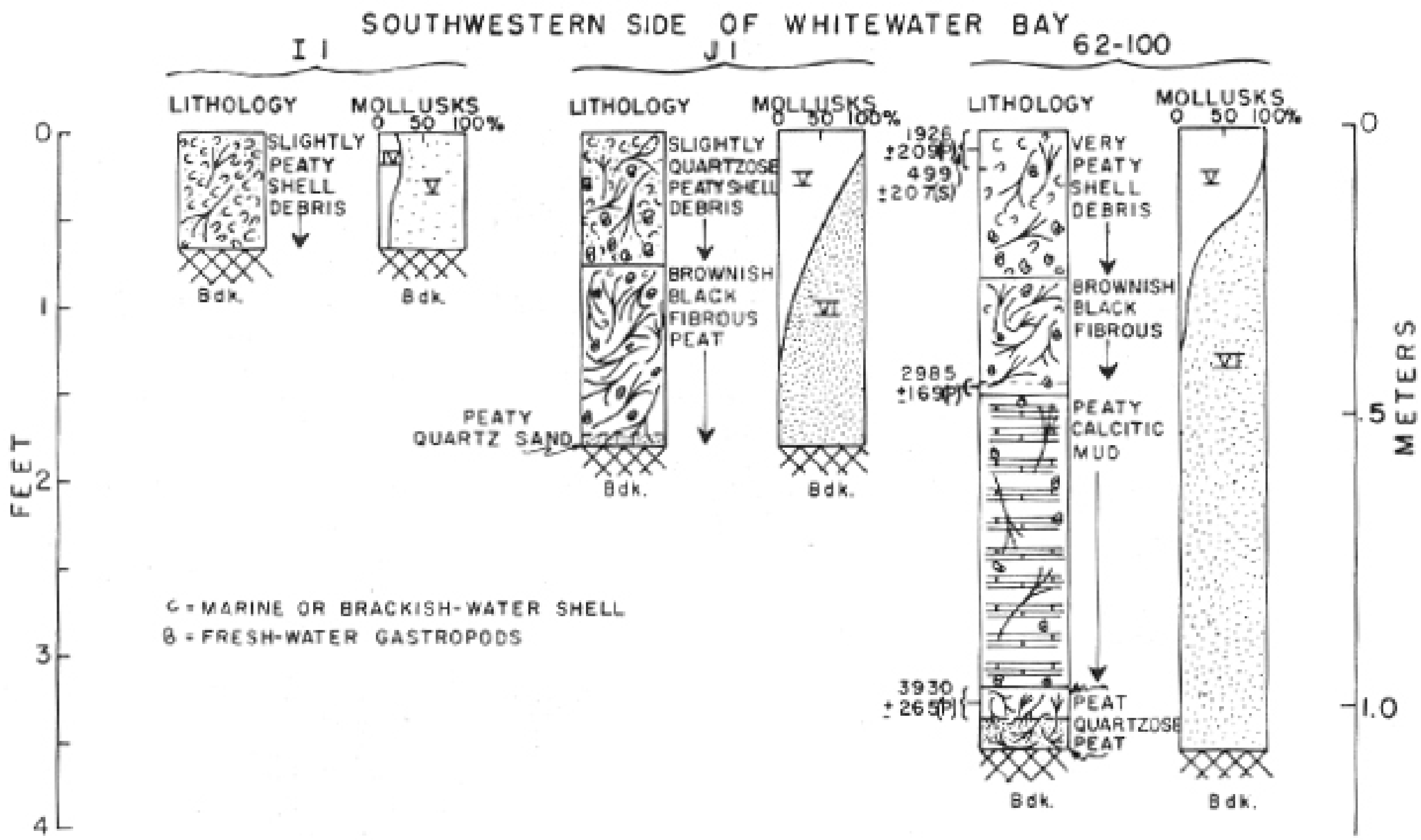


Figure 27 - Structural contours on the Miami oolite, which is the bedrock floor underlying the sediments of Whitewater Bay. The contours read in feet below mean sea level. A pre-Whitewater Bay drainage pattern is apparently delineated by the contours. Evidently the Watson (WR), North (NR) and Roberts (RR) Rivers drained southwestwardly across the area of Whitewater Bay towards Cape Sable prior to about 3500-3000 years ago. A bedrock high also appears to underlie Oyster Bay (OB), which is at the western end of Whitewater Bay.

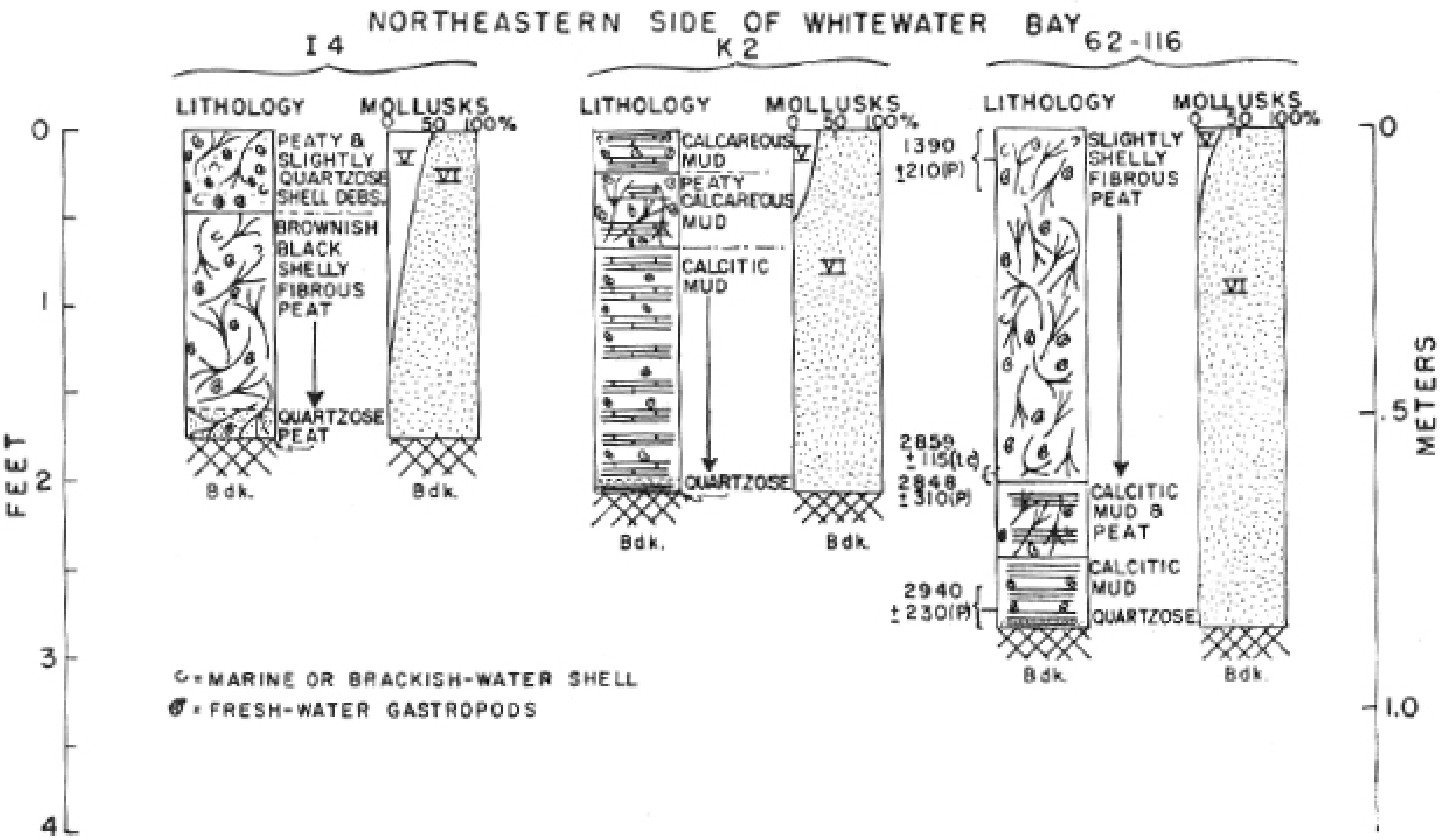


STRATIGRAPHY, AGE AND FAUNA OF SEDIMENTS UNDERLYING SOUTHWESTERN WHITEWATER BAY

Figure 28

Core stratigraphy, radiocarbon dates and molluscan fauna of sediments underlying the southwestern side of Whitewater Bay. Core locations are shown on Figure 26; faunal descriptions are given in Scholl (1963). Molluscan fauna IV is essentially marine, fauna V is a mixture of marine and brackish-water forms (polyhaline) and fauna VI is composed of fresh-water gastropods. Cores I1, J1 and 62-100 were taken at progressively greater distances into (or southeastwardly) Whitewater Bay from a point near its entrance.

Radiocarbon dates are given in years before 1950. Material used for C-14 age dating is designated by (p) for peat or plant remains, (s) for shell debris, and (tc) for total calcareous matter.



STRATIGRAPHY, AGE AND FAUNA OF SEDIMENTS UNDERLYING NORTHEASTERN WHITEWATER BAY

Figure 29

Core stratigraphy, radiocarbon dates, and molluscan fauna of sediments underlying the northeastern side of Whitewater Bay. See explanation for Figure 28.

deposited about 4000 years ago (see radiocarbon dates on Figures 28 and 29). The middle brackish-water section is chiefly composed of in situ (autochthonous) mangrove peat. According to radiocarbon dates, the peat began to form about 3000 years ago. The upper section consists of calcilutaceous and peaty marine and brackish-water shell debris over the southwestern and central regions of the bay, and gray, fine-grained calcitic mud (locally known as "liver mud") along the northeastern margin.

The basal calcitic mud in Whitewater Bay is mineralogically and texturally identical (Table 2) to calcitic mud (locally referred to as "marl") now forming in the fresh-water swamps of the Everglades. The two deposits also have essentially identical fresh-water molluscan

Table 2

Properties of Basal Calcareous Mud in Whitewater Bay and Surficial Calcareous Mud of the Everglades

	Whitewater Bay, basal 1.4 feet of core taken near the southeast end of bay	Surficial 0.5 feet of core taken in Everglades near Homestead, Florida
Median diameter	0.008 mm	0.008 mm
Sorting Coefficient	2.34	1.65
Percent Calcite	98-99	98-99
Percent aragonite*	1-2	1-2
Percent high-Mg calcite	0	0
Sr/Ca X 10^3	2.40	1.75
Ca/Mg	95.7	80.9
Radiocarbon age	ca. 3400 B.P.	726 B.P.

* Due to the presence of fresh-water gastropod shells; chiefly genera of Helisoma, Physa and Planorbis.

faunas (principal genera are Helisoma, Physa and Planorbis). Deposition of the brackish-water mangrove peat on top of the fresh-water calcitic mud and fresh-water peat in the Whitewater Bay area must have been caused by marine flooding and the growth of a mangrove forest over a former region of the Everglades (Scholl, in press, B). Continued submergence apparently destroyed the mangrove forest that deposited this peat and brought about the deposition of the shelly surface sediment that overlies most of the bay. Influx of marine water into the bay is also reflected by a sharp increase in the relative abundance of aragonite over calcite in bay sediments; the aragonite is chiefly derived from mollusk shells (Figure 26 and Taft and Harbaugh, 1964).

STOP 14: Oyster Bay Site

Objectives:

A. Inspection of sediments in the open water area near the entrance to Whitewater Bay.

B. Discussion of the sedimentary facies in Florida Bay, Whitewater Bay and Oyster Bay.

C. Discussion of the relationship between the marine transgression and post-glacial sea level rise.

Discussion:

Broadening of Whitewater Bay to its present size has apparently been under way since about 3000 B.P. Because southern Florida is thought to have remained tectonically stable during this time, the sedimentary section in Whitewater Bay must record the final phases of the world-wide post-glacial rise in sea level (Scholl, in press, A). A curve showing this rise in sea level across southern Florida is given in Figure 30.

The next stop, Stop 14, will be west of Cormorant Pass in Oyster Bay (Figure 27). This area is near the entrance to Whitewater Bay and therefore is swept by tidally generated currents. As a consequence, the floor is covered with only a thin veneer of relatively coarse shelly sediment. The molluscan fauna is also essentially marine in character.

STOP 16: Cape Sable Buried Forest

Objectives:

A. Inspection of the effects of shoreline processes interacting with swamp environment processes - Sector 1: an "exposed" coastline.

B. Inspection of a black mangrove swamp.

C. Discussion of Cape Sable shoreline development.